BONE CONNECTION DEVICE

BACKGROUND OF THE INVENTION

[0001] The invention concerns an implantable orthopedic device with a load-bearing element such as a bone plate, with at least one opening for a fixation element such as a bone screw. An insert is provided that can be inserted into the opening in a receptacle in which the external shape of the insert is at least partially complementary to the internal shape of the receptacle. The insert has a central through-bore for mounting a body of the fixation element. The implantable orthopedic device has a structure for holding the insert in the receptacle.

[0002] A series of implantable orthopedic devices with load-bearing elements, such as bone plates, with openings for the insertion of fixation elements in such load-bearers are known from the prior art. Among them are proposals for the mono-axial as well as poly-axial attachment of fixation elements, particularly screws.

[0003] As an example for a device of this type having poly-axial attachment of screws in load-bearing elements is shown in U.S. Patent No. 5,954,722. Other bone plates with inserts are shown in U.S. Patent Nos. 5,976,141 and 5,607,428.

[0004] Among the proposals in the prior art is WO 00/53110 (U.S. Patent Publication No. 2002/0045901) which publication relates to an elongated bore in a load-bearing element, which is, on one end, semicircular with rounded-off edges, and which exhibits on the opposing end what essentially is a half thread. The threaded end extends at an angle of more than 180 degrees. With this, it is possible to screw a screw into the threaded side at right angles to the load-bearing element, so that the screw is also firmly connected to the load-bearing element. On the opposite side of the bore, it is possible to screw in a screw at a desired angle

perpendicular to the load-bearing element, particularly poly-axially. These screws are, however, not stably locked in the axial direction.

[0005] The prior art exhibits the disadvantage that the screws are intended exclusively for insertion with specifically designed load-bearing elements, and thus only a specific type of insertion, such as, for example, poly-axial attachment or mono-axial attachment, is possible. Inserts for bone plates are known from U.S. Patent No. 5,190,545.

SUMMARY OF THE INVENTION

[0006] It is an object of the invention to improve the prior art devices in such a way that a true variety of screws or other means of attachment for various types of attachment can be inserted.

[0007] This object is achieved by an insert which can be engaged with the load-bearing element in a manner which results in the insert being firmly fixed. With a suitable insert, an angled position and specifically any desired defined angular position can be obtained. Of particular advantage is that the secure fixing of the insert can be assured directly and automatically with the insertion of the fixation element.

[0008] These and other objects of the invention are achieved by an implantable orthopedic device or bone stabilization device comprising an elongated bone plate having a plurality of apertures extending through the bone plate. At least one insert is provided having a body with a threaded bore and outer surface for engaging an inner surface of the aperture. At least part of the aperture is surrounded by a locking surface and the insert outer surface has a resilient extension for engaging the locking surface. Thus, the insert may be inserted into the aperture from a top surface of the plate with a resilient extension engaging the locking surface in the aperture thereby resiliently coupling

the plate in the insert. The threaded bore of the insert could be angled with respect to the top surface of the plate or could be perpendicular thereto. Preferably, the axis of the aperture extending from a top plate surface to a bottom plate surface is perpendicular to the plate top and bottom surfaces. The locking surface could be a ledge or a ridge extending at least partially around the inner surface of the aperture or one could utilize the bottom plate surface as a ridge for engaging the resilient extensions of the insert. The extension on the insert may have an outwardly extending lip which engages under the ledge or plate bottom surface to prevent the insert from being removed from the aperture.

[0009] Through the provision of a kit with various inserts with inclined axes, and inner bores on which the screws can be mounted, the surgeon can be provided with a bone plate able to orient bone screws at a number of defined angles in a simple manner. For this reason, the insert is provided with an oval configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention will be better understood on reading the following detailed description of non-limiting embodiments thereof, and on examining the accompanying drawings, in which:

[0011] FIG. 1 is a top view of a load-bearing element in the form of a bone plate with a row of attachment bores according to a first embodiment of the invention;

[0012] FIG. 2 is a sectional side view of the load-bearing element according to FIG. 1 along lines 2-2;

[0013] FIG. 3 is a top view of the load-bearing element according to FIG. 1 with the insert of the present invention inserted therein;

[0014] FIG. 4 is a sectional side view of the load-bearing element with insert inserted according to FIG. 3;

[0015] FIG. 5 is a perspective view of a first insert to be used with a load-bearing element according to FIG. 1;

[0016] FIG. 6 is a side view of the long side of the insert according to FIG. 5;

[0017] FIG. 7 is a side view of the narrow side of the insert according to FIG. 5;

[0018] FIG.8 is a sectional side view of a load-bearing element according to a second embodiment of the invention;

[0019] FIG. 9 is a sectional side view of a load-bearing element according to FIG. 8 with an insert inserted according to the second embodiment;

[0020] FIG. 10 is a sectional side view of the long side of another insert for use with a load-bearing element according to FIG. 1 or FIG. 8;

[0021] FIG. 11 is a sectional side view of the narrow side of yet another insert for use with a load-bearing element according to FIG. 1 or FIG. 8; and

[0022] FIG. 12 is a perspective view of an insert modified from that in FIG. 5 for use with a load-bearing element according to FIG. 1 or FIG. 8

DETAILED DESCRIPTION

[0023] FIG. 1 shows a top view of a load-bearing element in the form of a plate 1 with a row of attachment bores 2 arranged along the longitudinal direction of plate 1 according to a first embodiment of the invention. Bores 2 are through-bores that exhibit an oval central opening 3. At opening 3 there are two side walls 5 on opposite sides of axis 4 which extend parallel to the direction of longitudinal axis 4 of plate 1 and extend at right angles to the surfaces of the plate. These parallel side walls 5 are connected on both ends by semicircular walls 6, each forming a semi-cylindrical boundary so that together the aforementioned oval opening 3 results.

[0024] In other forms of the invention, oval bores 2 can also be provided. Bores 2 can also be elliptical or of a common elongated form. What is essential is the multiplicity of functions for the selection of attachment elements or fasteners made possible by insert 10 shown in FIG. 5. Through the mostly elongated form of plate 1, elongated bores 2 are preferred over circular bores in order to maintain flexibility with the insertion of screws with larger diameters. In one embodiment not shown in the drawings, the bore may be essentially cylindrical with the disadvantage that the insert has less material for providing inclined holes in the insert. The elongated form that is asymmetrical with respect to axis 13 (FIG. 4) but rather is symmetrical only with respect to one of the long axes 4 and the flat surfaces enclosing axis 13 actually provides the opportunity, through suitable inserts (see FIG. 10 and 11), of firmly fixing defined angles in inclined axes 43 and 53.

[0025] Arranged around the not necessarily circular or cylindrical walls 5, 6 forming opening 3 is chamfered surface area 7, extending and tapering inwardly from the upper surface 8 of plate 1 that faces away from the bone during implantation. The form of this area 7 can be more easily seen in the cross-section of FIG. 2 and is preferably part-spherical.

[0026] FIG. 2 shows a sectional side view of the load bearing element or bone plate 1 according to FIG. 1. Similar characteristics appear in all figures with the same reference numerals. From FIG. 2, one can clearly see in a preferred embodiment, tapered area 7 in the longitudinal direction of axis 4, forms an angle of 37.5 degrees with surface 8. This results in an angle of 142.5 degrees to side walls 5, 6. Naturally, other angles are also possible, particularly it would be possible to have a bore 2 that has no chamfered area 7, which would thus exhibit a purely cylindrical or

oval-cylindrical inner boundary surface. The top surface 8 of load-bearing element 1 is formed somewhat deeper in the side area 18 near bores 2. The same is true for upper edge 15 of side wall 5, which are shown to be lower (closer to the plate bottom surface) in a direction opposite the bore ends in longitudinal direction 4. Bottom surface 9, which is closest to the bone in insertion during surgery is here locally flat. Normally, plates 1 can exhibit continuous surfaces 8 and undersurfaces 9 which at each point, for the function of positioning on the bone can always be considered to be flat. But here too, positioning on curved or bent surfaces can be provided.

[0027] FIG. 3 shows a top view of the load-bearing element or plate 1 according to FIG. 1 with insert 10 located in bore 2. Each insert 10 is designed to be shaped complementary to bore 2 for locking therein with respect to areas 7 and side walls 5. Insert 10 has a central bore 11 with an internal threading 12.

[0028] FIG. 4 shows a sectional side view of the load-bearing element 1 with insert 10 according to FIG. 3 therein. For this, a first embodiment for insert 10 was selected in which main axis 13 of central bore 11 runs perpendicular to surface 8. In the preferred embodiment, insert 10 has an area 19 that extends beyond lower surface 9 that is adjacent the bone. In particular, insert 10 has locking mechanisms that are better shown in FIG. 5 and are not visible in FIG. 4 because they are along its edges. In particular, the locking mechanism can be two projecting rims that engage the underside of plate 1 after the insertion of insert 10. This will be explained in more detail in connection with FIGS. 5 to 11. In any event, insert 10, when it is inserted into plate 1, with its extension area 19, forms a distance spacer with regard to the bone material into which a screw that has been inserted into bore 11 is turned.

[0029] FIG. 5 shows a perspective view of an insert 10 to be used with a load-bearing element 1 according to FIG. 1. The reference numeral 21 refers to the surface of insert 10 having a circumference 22 that meets with the edge of area 18 of plate 1. In the preferred embodiment, a spherical surface 23 extends downwardly from surface 21 and is shaped so as to have complementary surface contact with surface 7. In cutting this recess by means of spherical cutting spherical areas are formed in surface 23. Semicircular extension 24 extends downwardly from surface 23 and is in conforming contact, without any significant play, with area 6 of bore 2.

[0030] The area lying opposite the longitudinal surface 5 consists of a resilient extension 25 on each side, in which, in the preferred embodiment shown, each extension 25 is provided with slots 26. Each extension 25 has, on its lower edge, a projecting rim 27 facing outward from the point of view of the insert with an upward-facing shoulder 28 with an outer edge 29. Preferably, projecting rim 27 is only slightly rounded in going toward shoulder 28. The surface of rim 27 that is facing toward the bone is then preferably inclined. Extension 25 is also to a certain extent, flexible. In inserting insert 10, extension 25 then slides into bore 2 and is deflected inwardly by the projecting rim 27. Once insert 10 is completely inserted, shoulder 28 slides against underside 9 of plate 1 and locks insert 10 in plate 1. This locking is additionally ensured by the subsequent insertion of a bone screw (not shown). Through the pressure of the screw on the internal thread of extension 25 inward deflection of extension 25 is prevented so that projecting rim 27 is secured under plate 1.

[0031] It should be noted that extension 25 and with it projecting rim 27 need not necessarily be arranged as two extensions 25 on the opposing longer sides of insert 10. The

design can also include resilient extensions on the narrow sides of an insert, i.e. corresponding to the location of the semicircular cylindrical extensions 24. Extensions 25 can also be arranged in an alternating manner. There can also be only one or two more extensions.

[0032] Extensions 25 can act as spacers. This can be even further accentuated, as shown in FIG. 12.

[0033] FIG. 6 shows a side view of insert 10 according to FIG. 5. Extension section 19 is provided in side areas 7. The projecting rim 27 is formed on an end area of extension 25. Slots 26 extend to the area of spherical surface 23. Of course slots 26 can also be designed to be shorter or longer.

[0034] FIG. 7 shows a side view of the narrow side of insert 10 according to FIG. 5.

[0035] FIG. 8 shows a cross-sectional view of a load-bearing element 31 according to a second embodiment of the invention and FIG. 9 shows a top view of the load-bearing element 31 according to FIG. 8 with insert 30 inserted according to the second embodiment. The difference between the first and second embodiments is that in the second embodiment at least along the length of the longitudinal axis 4 of the load-bearing element 31 is that recess 33 is provided on the bottom surface 9 around opening 2. This recess can also be provided on the narrow side, as shown in FIG. 8. In addition, insert 30 is provided with a projecting rim 27 that is arranged in such a way that the bottom of insert 30 does not project beyond lower surface 9. The underside 29 of insert 30 is thus at least flush with the aforementioned surface 9 of the load-bearing element 1. Otherwise, the resilient engagement of insert 30 in recess 2 is designed in the same way as the engagement of the first embodiment. But here, if desired, the underside 29 of

insert 30 can extend beyond the aforementioned surface 9 of the load-bearing element.

[0036] FIG. 9 shows a sectional side view of load-bearing element or bone plate 31 according to FIG. 8 with insert 30 according to the second sample embodiment inserted therein.

[0037] FIG. 10 shows a sectional side view of a long side of another insert 40 to be used with a load-bearing element 1 according to FIG. 1 or FIG. 8. Insert 40 preferably has a flush underside 29, but could also be configured similarly to underside 19 and extend beyond plate surface 9. The main difference between insert 40 and the insert shown in FIG. 5 lies in its internal bore 11. Axis 43 of bore 11 is slanted preferably at about 15 degrees in the direction of the longitudinal axis 4. Preferably, in a kit provided for surgery, there would be a series of different inserts with various angles, of, for example 5, 10, 15 and 20 degrees, to name a few possible values. As bores 2 are symmetrical with respect to axis 13, and relatively symmetrical with respect to the perpendicular to the longitudinal axis 4, inserts 40 can be inserted turned 180 degrees. Thus, each insert with a specified angle of, for example, 15 degrees, can be inserted at a plus 15 degree or a minus 15 degree angle.

[0038] FIG. 11 shows a sectional side view of a narrow side of yet another insert 50 to be used with a load-bearing element 1 according to FIG. 1 or FIG. 8. The preferred insert 50 has an underside 19 extending beyond the bottom plate surface 9 but could also be configured similarly to underside 29 and be flush with the bottom plate surface. The main difference between alternate insert 50 and the insert shown in FIG. 5 lies in its internal bore 11. Axis 53 of bore 11 is shown to be inclined in the direction toward longitudinal axis 4 for example at an incline of 5 degrees, i.e. in a plane perpendicular to the offset shown in FIG. 10. Preferably, in a set provided for surgery, there would be a

series of different inserts with various angles, of, for example, 2.5, 5, 7.5 and 10 degrees, to name a few possible values. As bores 2 are symmetrical with respect to axis 13, and relatively so with respect to the longitudinal axis 4, inserts 50 can be inserted turned 180 degrees, so that having each insert with a specified angle, the corresponding "negative" angle is also covered. The angles provided for the embodiments of insert 50 according to FIG. 11 are significantly smaller, since the bore width is less than the length. The angle is about half the size than in the sample embodiments of insert 40 according to FIG. 10. This is because axis 53 is angled perpendicular to the elongated portion of load-bearing element 1 and bore 2, such that there is less room in the insert for the bore to be angled. Generally, steep angles are not necessary, as fixation elements such as screws are generally arranged in essentially the same and/or similar angles to load-bearing element 1. It is also possible to provide inserts inclined in both the aforementioned directions (i.e. with inclines corresponding to axis 43 and axis 53) of FIGS. 10, 11, respectively.

[0039] FIG. 12 shows a perspective view of an insert 60 which is modified from insert 10 according to FIG. 5. Insert 60 may to be used with a load-bearing element 1 according to FIG. 1 or FIG. 8. Reference 61 refers to a groove that is set into extension 25 to increase resilience. Groove 61 runs between two slots 26. As discussed above, surface 23, forming a spherical base with respect to upper surface 21, is built in so as to have complementary surface contact to surface 7. In the embodiment according to FIG. 12, groove 61 is set at the upper end area of slit 26, in order to allow the maximum spring action. This produces an area 62 from which extends spherical area 23.

[0040] Although the described drawings already show a whole series of possible configurations of the invention, the

invention is and should be limited only by the parameters of the attached claims.

[0041] The advantage of the invention is that it offers the surgeon, with a plate 1 with conventional standard bores 2, the possibility of forming a plurality of angularly-stable mono-axial bore by means of an inset, and furthermore, that this is made possible intra-operatively.

[0042] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.